NOTE: EH-74 developed this study guide material in support of the Technical Qualification Program's Radiation Protection area. It is added to this study guide for your convenience. An updated version is in the process of being reviewed and approved by DOE-HR. The material offered here will be replaced when it is approved and made available.

Competency 1.8 **Emergency management personnel shall demonstrate a working level knowledge of decontamination procedures.**

1. Supporting Knowledge and/or Skills

a. Describe the equipment and layout required for a decontamination area.

b. List the eight basic methods of decontamination and when they would be applicable.

c. Describe the decontamination process for chemically- or radioactively-contaminated personnel.

d. Describe the decontamination process for chemically- or radioactively-contaminated equipment.

e. Explain the priorities for treatment of radioactively-contaminated, injured personnel.

f. Explain the priorities for treatment of chemically-contaminated, injured personnel.

2. Summary

Facility and Equipment Requirements for a Decontamination Area

Personnel Decontamination

The area selected for assessing and treating the contaminated and/or injured patient should have a separate entrance, be located away from the usual traffic flow, havethe necessary emergency medical equipment and supplies readily available, and should be sufficiently large to accommodate the victim, staff members, and all the necessary equipment including the appropriate radiation survey instruments calibrated and ready for use. A control line should be established at the entrance to the decontamination room that allows only authorized personnel to enter, and no person or equipment to leave until monitored.

The most basic equipment required in the decontamination room would be a decontamination table, at least three five-gallon containers for wash water, three large waste containers lined with plastic bags, various sizes of plastic bags for samples, clothes, cotton-tipped applicators, stoppered containers for swabs taken from contaminated areas of the body, small lead storage containers (pigs) for holding radioactive foreign bodies removed from wounds, anatomical charts for recording contaminated areas found on the body, solutions or materials for decontamination (sterile saline, water, sodium hypochlorite (bleach), surgical soap, abrasive soaps, shampoo, soft scrub brushes, sheets, blankets, towels, gowns, and all necessary airways, intubation, IV solutions, etc.).

Equipment Decontamination

Ideally, an enclosed area with a nonporous floor sealer and wall covering would be recommended so that both adsorption and absorption of contaminants to the flooring and walls of the facility would be reduced to a minimum. Sink drains and floor drains should not be connected directly to the regular sewer system, but should carry waste water to holding tanks buried outside the facility. Regular monitoring of these waste tanks should occur to ensure a safe release into the regular sewage system at a later time. A large supply of plastic bags of various sizes should be on hand for disposal of solid waste, along with a variety of steel drums.

Decontamination Techniques

Eight basic methods of possible decontaminating techniques (equipment or personnel) arranged from the most simple to the most drastic start with tape patches, vacuum cleaning, water, detergents, steam, ultrasonic vibrations, complexing agents, and organic solvents.

1. Tape patches are most effective in removal of unfixed radioactivity on smooth surfaces such as metal or porcelain counter tops. Tape patches are fairly effective on skin decontamination where hair is sparsely grown.
2. Vacuum cleaning is generally used for decontaminating walls, floors, or equipment, but may also be used, in special situations, in decontaminating personnel.
3. Water is always a good choice in attempting to decontaminate equipment or personnel.
4. Detergents and shampoos are usually required for more effective removal of contaminants. Must be selective when choosing a detergent or shampoo.
5. Steam is unrealistic for use on personnel, but may be a good choice for selective equipment, walls, floors, etc.
6. Ultrasonic vibrations are fairly effective on smaller items such as rings and things.
7. Complexing agents are not recommended for human use except under strict supervision of a physician.
8. Organic solvents are not recommended for human use except under strict supervision of a physician.

Decontamination Process for Chemically or Radioactively Contaminated Personnel

It is recommended that external contamination (skin and/or hair) be removed by one or more of the basic decontamination techniques previously described. Internal deposition of radioactivity, however, is a much more complicated situation. Once radioactive materials cross cell membranes, they are said to be incorporated. Incorporation is a time-dependent, physiological phenomenon related to both the physical and chemical natures of the contaminant. The rate of incorporation can be quite rapid, occurring in minutes, or it can take days to months. Thus, time can be critical and treatment is urgent. If internal contamination is suspected or has occurred, requests for samples of urine, feces, vomitus, wound secretions, etc., should be initiated by the physician or radiation safety officer. Whole-body counting and radioassay can also be useful in evaluating the magnitude of the problem and the effect of any treatment. Treatment for internal deposition of radioactive materials usually involves the repetitive use of strong chemical agents called chelators and is accomplished only under the watchful eye of an experienced physician.

Decontamination Process for Chemically or Radioactively Contaminated Equipment

Protective clothing and containment are the key elements in dealing with decontaminating chemically or radioactively contaminated equipment. Protective clothing is intended to prevent transferable contamination, fumes, or airborne contaminants from coming in contact with the skin, being inhaled, or being ingested into the body. Clothing over the skin not only protects this organ, but reduces exposure to lower energy beta radiation as well. Inhalation and ingestion of contaminants may be prevented by wearing a full face respirator with the appropriate filters. A well-organized safety plan would include properly fitted protective clothing, medically approved wearers of full face respirators, having been custom fitted if necessary and leak tested in every case. Protective clothing is usually selected based on the contamination level in the work area, the anticipated work activity, and other worker health considerations. A review of the personal protective clothing ensemble includes a hard hat (optional), hair net, protective hood, full face respirator, coveralls (tyvex disposable or cotton), pocket dosimeter, cotton glove (insert), rubber gloves (outsert), booties, rubber boots (optional), and duct/masking tape to seal all openings (wrists, ankles, and seams).

Containment of chemicals or radioactivity accidentally released into the environment is an important step in the decontamination process. Preventing the expansion of the contaminant reduces the magnitude of an event, allowing the responder to maintain better control of a situation. Another method of minimizing the decontamination process is to practice confinement of as many contaminated articles as possible (i.e., wrap them in plastic or place in plastic bags, seal, and label).

The actual act of decontamination involves washing with a solution (solvent or plain water) and catching the runoff in the appropriate container. Soapy solutions or even harsh abrasives (sandblasting) may be used in the decontamination process depending upon what is being decontaminated. Nevertheless, all materials used must be accounted for and stored or properly disposed of in large plastic bags, which are then placed in stainless steel drums that are accurately labeled and tightly secured.

If during triage injuries are discovered, attention is immediately directed to the medical needs of the victim. Serious medical problems always have priority over radiological concerns, and immediate attention is directed to these life-threatening situations. Examples of such conditions could be an airway obstruction causing difficult breathing, severe bleeding, or symptoms of going into shock. Only after the injured person has become stabilized does the decontamination process begin.

Unlike the radioactively contaminated injured person, where radiation injury rarely causes unconsciousness or immediate visible signs of injury and is not immediately life-threatening, a chemically contaminated person can present a serious problem. Caustic chemicals such as strong acids or strong bases, taken either internally or externally, must be diagnosed and dealt with immediately. In the absence of a physician, check container labels for antidote or call the poison control center in the area for first aid treatment. Transport victim to the nearest medical facility as soon as feasibly possible.

3. Self-Study Scenario/Activities and Solutions

Review

- 10 CFR 835, *Occupational Radiation Protection*.
- DOE Order 151.1, *Emergency Management System*.
- NCRP Report No. 65, *Management of Persons Accidentally Contaminated with Radionuclides*.

Scenario 1

NOTE: The following scenario and scenario solution were adapted from an actual occurrence.

Three employees at the Ace Metal Recycling Center were working on a special project that involved cutting radioactively contaminated long metal rods into short pieces for disposal. They were using a hand-held circular saw with a metal cutting blade. Since the rods were contaminated with radioactivity, the employees were required to wear full protective clothing at all times while dealing with this material. Two of the employees were holding one of the metal rods in position,

while a third employee manipulated the heavy cutting saw. Once cut, the shorter pieces of rod were packaged for radioactive waste disposal. After several hours of this laborious task, the employee operating the saw became fatigued and allowed the circular blade of the saw to ricochet off the metal rod onto the gloved right hand of one of the employees ("1") holding the rod. While attempting to recover from this error, the employee with the saw jerked the saw up and away from the lacerated hand; however, before gaining complete control of the saw, the falling motion of the high-speed saw blade fell across the forearm of the employee, slicing another gash. Finally, the employee operating the saw located the on/off switch and stopped the saw. Meanwhile, the second employee ("2") holding the rod had removed his gloves and began wrapping the wounds of the injured man with rags. Realizing the seriousness of this accident, the supervisor made the decision to transport all three workers to the Radiation Emergency Assistance Center Training Site (REAC/TS), located in Oak Ridge, Tenn., for evaluation and treatment. What treatment should be administered to the employees?

Your Solution:

Scenario 1, Solution
(Any reasonable paraphrase of the following is acceptable.)

The three employees and their supervisor arrived at REAC/TS, where the facility nurse and a research associate triaged the victims for injuries and radioactive contamination. The right sleeve of the coverall worn by employee "1" was cut off at the shoulder and carefully removed, and his gloves and all makeshift bandages were carefully removed. The employee had a severe laceration across the back of the right hand plus another wound on the right forearm. A physician was called immediately. Coveralls were also removed from employee "2" (it is estimated that by removing the coveralls, 70% of the radioactivity would be eliminated.) All bandages and clothing taken from both victims were properly labeled, placed in plastic bags, and sealed. A total body survey using a G-M handheld survey meter with a pancake probe revealed the presence of radioactive contamination on both employees. It was noted that most of the radioactivity found on employee "2" was on his hands. While waiting for the physician to arrive, the bandages, gloves, and clothing that had been removed were taken to the laboratory for assay. Simultaneously, an accident history was given by the supervisor.

Upon the arrival of the physician, employee "1" was diagnosed as having sustained major damage involving ligaments, tendons, vessels, and tissue. Although radioactivity was not the greatest concern at this point, a wound swab was done for later analysis. Repair of the physical damage to the hand had priority; therefore, the employee was taken to surgery immediately. Employee "2" was assessed as having surface contamination on both hands. After thoroughly washing the hands several times using a mixture of 50% cornmeal and 50% granular detergent, the employee still had contamination on both hands. Next, a solution of 50% hypochloride and 50% water was used to wash the hands; however some contamination still remained. Therefore, the hands were dried and plastic bags were placed over them, taped down, and allowed to remain overnight (perspiration resulting from this procedure aids in removing contaminants from deep within the pores of the skin.)

The following day, employee "1" was recovering from the first of many surgical procedures that would follow. Amazingly, results of the radioassay on the swabs from employee "1" showed no contamination in either wound. It was thought that any radioactivity on the saw blade may have been wiped off by a combination of the contact of the fabric of the glove to the saw blade and the flushing action caused by the profuse bleeding. Employee "2" returned to REAC/TS for removal of the plastic bags and monitoring. He was found to be below the maximum permissible body burden and released.

The radionuclides found to be present on the bandages, gloves, and clothing were Co-60, Cs-137, and Mn-54.

4. Suggested Additional Readings and/or Courses

Readings

- Gollnick, D. A. (1988). *Basic Radiation Protection Technology* (2nd ed.). Pacific Radiation Corporation: Altadena, CA.
- Argonne National Laboratory. (1988). *Department of Energy Operational Health Physics Training* (ANL-88-26). Argonne, IL: Author.

Courses

NOTE: See Appendix B for additional course information.

- *Applied Health Physics* -- Oak Ridge Institute for Science and Education.
- *Health Physics in Radiation Accidents* -- Oak Ridge Institute for Science and Education Radiation Emergency Assistance Center Training Site (REAC/TS).

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